NASA Glenn SiC JFET IC Generation 13 Starting SiC Wafer Specifications

Given below are the formal technical specifications used when NASA Glenn Research Center purchased (via open competition Governmental purchasing process) the starting wafers with epilayers that will be used for the upcoming NASA Glenn SiC JFET-R IC Generation 13 prototype wafer fabrication run.

The major differences between IC Gen. 12 epi-wafer specs and IC Gen. 13 epi-wafer specs are highlighted in red text.

The silicon carbide wafers with epitaxial layers shall meet the following specifications:

(a) Shall be a single crystal of the 4H polytype.
(b) Shall be round with a diameter of 100 mm ± 0.5 mm, and a thickness of 0.3 mm ± 0.1 mm, and with both sides polished.
(c) On the back of each wafer, identifying numbers/letters shall be produced by a laser patterning process near the primary wafer flat.
(d) Shall be nitrogen doped (n-type) with a resistivity less than 1 ohm-cm and with average micropipe density of less than 2 per square cm.
(e) At least 70% of the top surface area (with a 3 mm edge exclusion) shall be usable for devices of 2 mm x 2 mm area arrayed across the wafer surface, i.e., free of area defects including hexagonal platelets, foreign polytypes and orange peel as defined in SEMI specification M55-4-0315.
(f) Shall be (with a 3 mm edge exclusion) entirely free of optically observable crack defects that are in excess of 5 mm in length.
(g) Shall have flats in conformance with SEMI specification M55-4-0315.
(h) On the front of each wafer, there shall be the following singe-crystal homoepitaxial SiC epilayers, specified and verified by secondary ion mass spectroscopy (SIMS) analysis.
    (Layer #1) Deposited on top of the wafer substrate, a p-type aluminum-doped homoepitiaxial SiC layer of 2 x 10^{18} cm^{-3} ± 1.0 x 10^{18} cm^{-3} of 4.0 ± 1 micrometers thickness.
    (Layer #2) Deposited on top of the Layer #1 p-layer described above, a p-type homoepitaxial SiC layer of less than 5 x 10^{15} cm^{-3} of 6.0 ± 1 micrometers thickness. Lower doping is desired on a "best effort" basis, but the entire layer shall remain of p-type conductivity.
    (Transition Layer) Deposited on top of the Layer #2 described above, a doping transition layer from the p-type doping achieved in Layer #2 to the n-type doping described for Layer #3 below. The doping of this transition layer shall not anywhere exceed the n-type doping described for Layer #3 below anywhere in or between Layers #2 and #3. The thickness of this transition layer shall not exceed 0.04 μm in thickness, and smaller thickness is desired so long as the doping specification described above is met.

(Layer #3) Deposited on top of the Transition Layer described above, an n-type homoepitaxial SiC layer of 9.0 x 10^{16} cm^{-3} ± 2 x 10^{16} cm^{-3} of 0.35 ± 0.05 micrometers thickness.

(Layer #4) Deposited on top of the Layer #3, a p-type homoepitaxial SiC layer of greater than 1.7 x 10^{18} cm^{-3} of 0.05 ± 0.02 micrometers thickness.

(Layer #5) Deposited on top of the Layer #4, a p-type homoepitaxial SiC layer of greater than 1.0 x 10^{20} cm^{-3} of 0.2 ± 0.02 micrometers thickness. Higher doping is desired (up to 1 x 10^{21} cm^{-3}) on a "best effort" basis.

~~(i) Layers #1 through #4 described above in part (h) shall be grown in a single epitaxial growth run.~~ (NOTE: This technical specification was dropped by mutual agreement of the Government and the SiC epi-wafer contractor.)

(j) The epilayer (front) wafer face shall be the silicon face.

(k) The contractor shall provide Excel data file(s) of SIMS n-type and p-type doping vs. depth profiles measured from a test wafer proving growth of the 4H-SiC homoepitaxial epilayers conforming to all doping and thickness specifications listed in (h) above.